U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

NOAA Technical Memorandum NWS SR-74

# MIDWESTERN SNOWSTORM MODELS AND THE FEBRUARY 1973 STORM OVER GEORGIA

Rheinhart W. Harms, WSFO, Atlanta GA

SOUTHERN REGION HEADQUARTERS
SCIENTIFIC SERVICES DIVISION
FORT WORTH, TEXAS
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At 1200GMT February 9, Boothville reported a wind of 35 knots from the SSE at 850 mb. Brownsville had 40 knots from the northwest. Corresponding upper air charts indicated the jet stream was becoming organized over Georgia. At 500 mb, strongest winds were aligned over Columbus, Macon and Augusta (Fig. 3), the eventual location of the heavy snow band in Georgia (Fig. 4). Temperatures at 500 mb over southeastern Texas were generally colder than -19°C., a significant cold air temperature in the development of snowstorms (Govee, Paul A., and Russell J. Younkin, 1966). The pressure was falling at the surface over central Alabama and west central Georgia and satellite pictures gave indication of thickening cloudiness in cyclonic formation over the western Gulf.

THE CLIMATOLOGY OF SIGNIFICANT SNOWS IN GEORGIA

A review of snowfall records for 74 seasons (Table 1) indicates extreme variability from the mountainous terrain of north Georgia to the flat coastal plain of the south. Chattanooga, near the northern Georgia border, had 146 snows of one inch or more, December through April, whereas Tallahassee, near the southern border, had 3, all in the month of February (Fig. 5). Heavy snows of 4 inches or more have occurred in 31 storms at Chattanooga, but have not occurred south of the Albany-Alma-Savannah line during this period.

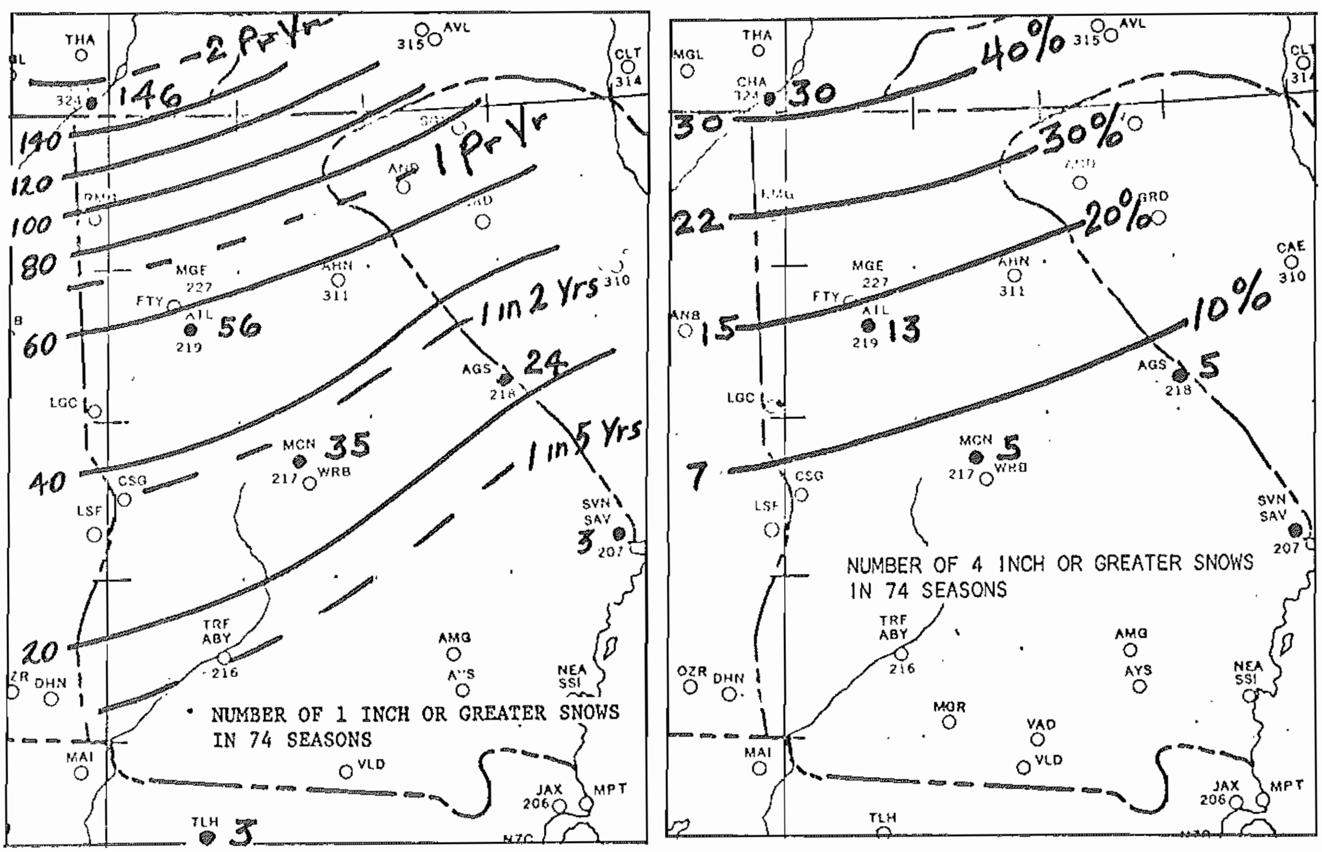


Fig. 5. Number of 1-and 4-inch snows in 74 seasons and frequencies of occurrences.

Table 1 FREQUENCY OF SNOWS IN 74 SEASONS

| | 1" | 2" | 3" | 4" or 5" | 6" or more | Record/Date | |
|---|---|---|---|---|---|---|---|
| DECEMBER | | | | | | | |
| Chattanooga | 12 | 5 | 1 | 7 | 2 | 8.6" | 12/27/29 |
| Atlanta | 10 | 2 | 1 | 1 | | 4.9" | 12/11-12/17 |
| Augusta | 4 | 0 | 1 | | | 2.6" | 12/22/35 |
| Macon | 5 | 2 | 1 | 1 | | 4.0" | 12/23/99 |
| JANUARY | | | | | | | |
| Chattanooga | 28 | 16 | 8 | 3 | 5 | 9.1" | 1/26-27/21 |
| Atlanta | 9 | 2 | 2 | 2 | 3 | 8.3" | 1/23/40 |
| Augusta | 6 | 1 | 1 | 1 | | 4.3" | 1/13/12 |
| Macon | 3 | 3 | 2 | 1 | | 3.7" | 1/23/55 |
| Savannah | | | | | | 0.5" | 1/27/21 |
| FEBRUARY | | | | | | | |
| Chattanooga | 20 | 9 | 1 | 2 | 6 | 10.1" | 2/10-11/12 |
| Atlanta | 8 | 2 | 2 | 4 | | 4.4" | 2/23/01 |
| Augusta | 2 | | 1 | 1 | 3 | 14.0" | 2/9-10/73 |
| Macon | 4 | 4 | 3 | 3 | 2 | 16.5" | 2/9-10/73 |
| Savannah | 1 | | 1 | 1 | | 3.6" | 2/8/68 |
| Tallahassee | 1 | 1 | 1 | | | 2.8" | 2/13/58 |
| MARCH | | | | | | | |
| Chattanooga | 12 | 2 | | 4 | 1 | 11.0" | 3/1-2/27 |
| Atlanta | 4 | | | 3 | | 4.0" | 3/11/60 |
| Augusta | 2 | | 1 | | | 1.7" | 3/9/32 |
| Macon | 1 | 1 | | | | 2.0" | 3/14/24 |
| APRIL | | | | | | | |
| Chattanooga | 1 | | | 1 | | 4.1" | 4/25/10 |
| Atlanta | | 1 | | | | 1.5" | 4/25/10 |

January and February are the months of greatest frequency of significant snows in Georgia. Their occurrence in December and March is mainly limited to the north and central portions of the state. Although they rarely occur in April, November and late October, examination of cooperative station records indicates an accumulation of 3 to 4 inches in the Gainesville-Clayton area on November 14 and 15, 1906. Recently, on October 29, an outbreak of Continental Polar air produced 5 inches of snow at Ellijay, also in the foothills of the north Georgia mountains. This was perhaps the earliest occurrence in the State in over 100 years. Chattanooga has received 4.1 inches as late as April 25 (in 1910).

Data for the period of record suggest that heavy snows of 4 inches or more are unlikely south of the Albany-Alma-Savannah line but may occur at times in the northern half of the state from December through March and at higher elevations of the extreme north in April, November, and late October.

*ABSTRACT*

*The record snowstorm which struck the Southeastern U. S. in February 1973 has been examined and its features compared with those of midwestern snowstorms. The climatology of significant snows of one inch or more in Georgia is also reviewed and techniques are proposed for forecasting snow distribution patterns and anticipating the need for watches or warnings.*

## *INTRODUCTION*

Never in the history of National Weather Service records in Georgia has a winter storm of such intensity and magnitude blanketed central and southern Georgia. Freezing rain and sleet preceded the snow as the cold air continued southward across the State. The storm center, which tracked eastward across the Gulf of Mexico and central Florida February 9th and 10th, 1973, deposited a heavy snow band from southeast Alabama across Columbus, Macon and Augusta in central Georgia into the Carolinas, with amounts in excess of 16 inches in many locations (Fig. 1).

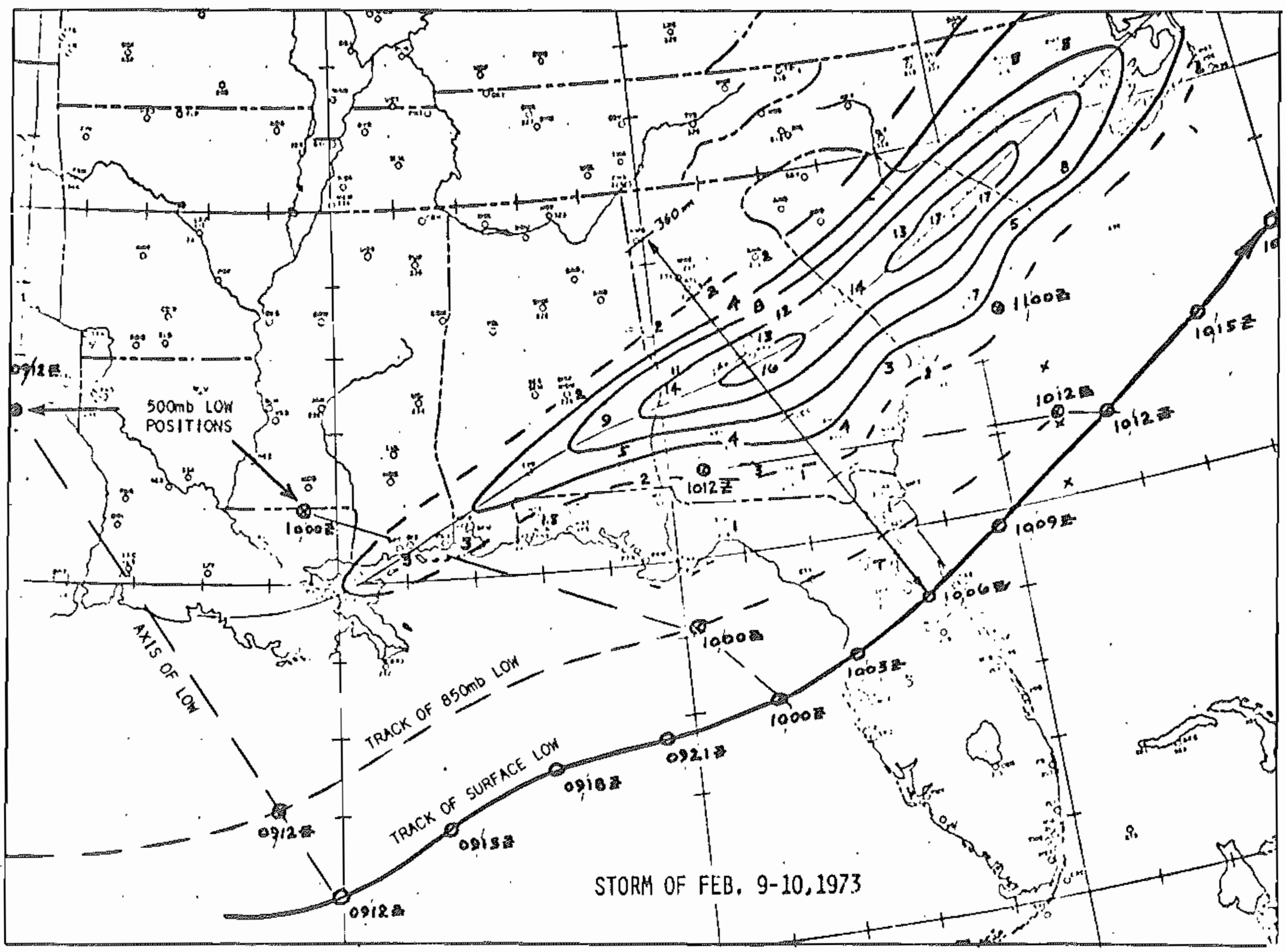


Fig. 1. Storm of February 9-10, 1973.

The storm of February 25, 1914, had been the record storm for central Georgia, producing 8 inches at Columbus and Augusta and 7 inches at Macon. This record, which stood for nearly 59 years, fell as Columbus and Augusta each reported new record snows of 14 inches. Macon with 16.5 inches had more than double its previous record.

Thousands of motorists travelling to and from Florida during the peak tourist season were stranded in the heavy snow. More than 4,000 cars were stalled on Interstate 75 between Forsythe and Cordele as snowplows were brought in from Tennessee and other northern States. According to newspaper accounts more than 25,000 motorists were stalled in the Carolinas.

*EARLY WARNING SIGNS OF A RECORD SNOW*

The cold HIGH pressure system which began building over the MacKenzie River Basin east of Alaska (Hodge,1973) on Monday, February 5 dropped the temperature to 46°F. below zero at Great Falls, Montana by early Wednesday morning, February 7. Afternoon temperatures Wednesday reached the 80's in parts of Texas. The cold airmass continued to plunge southward, reaching the coastal area of Georgia very early Friday morning February 9. Some evidence of cyclogenesis (Fig. 2) appeared in the western Gulf on the surface map of 2100GMT February 8 as the cold air became established over the Gulf. Rain along the Texas coast changed to sleet and snow.

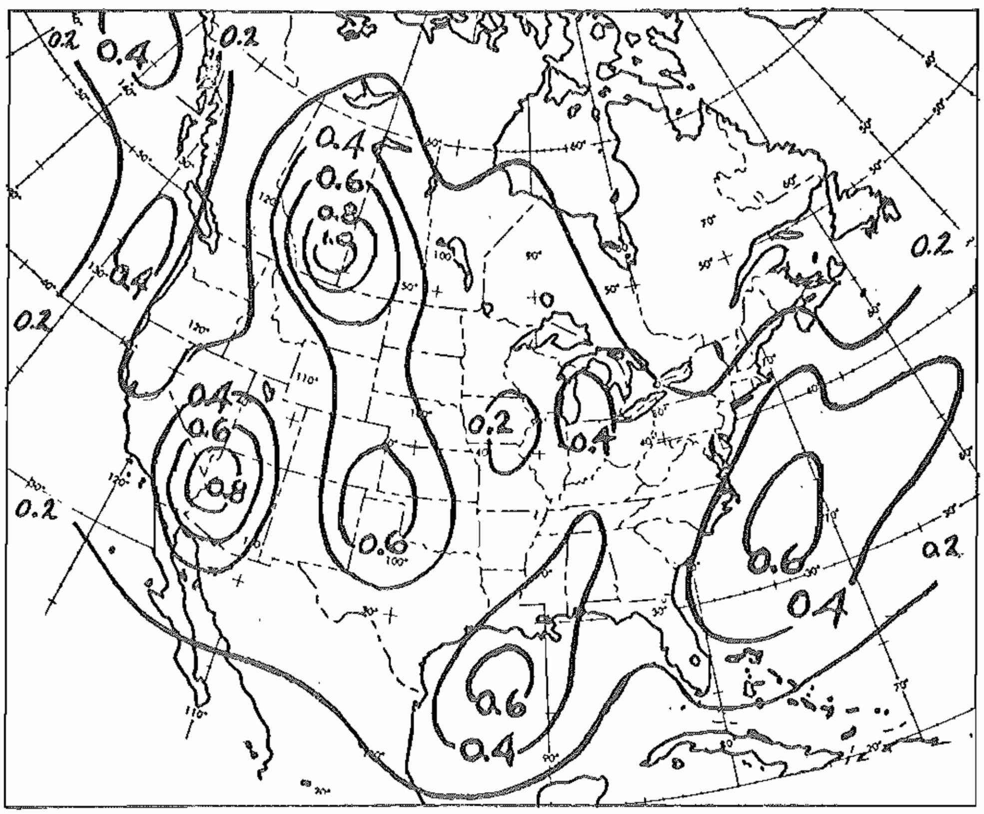


Fig. 2. Percentage frequency of occurrence of cyclogenesis in squares of $10^5$ $Km^2$ in Winter (1899 to 1939) (After Petterssen).

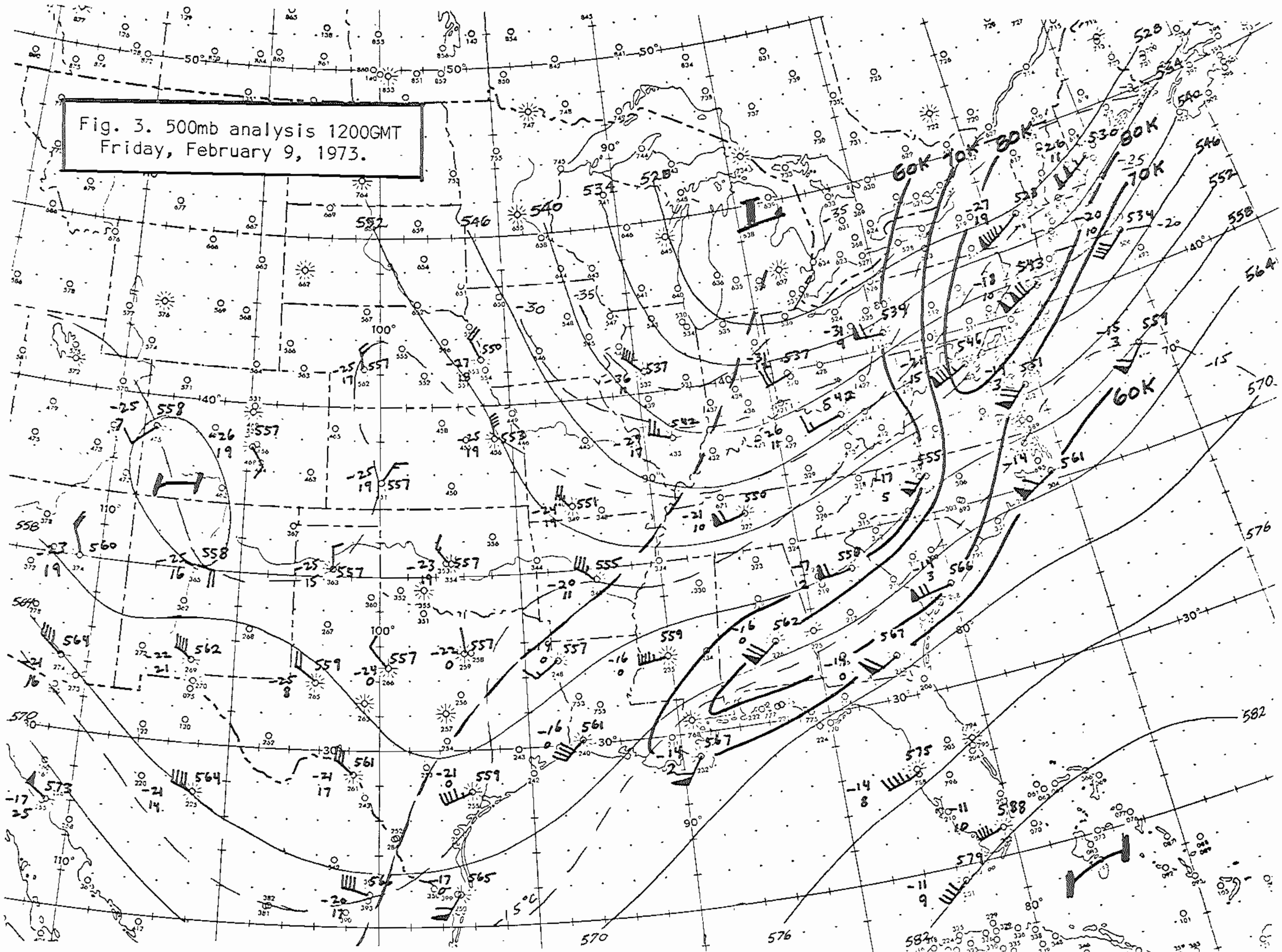

Fig. 3. 500mb analysis 1200GMT
Friday, February 9, 1973.

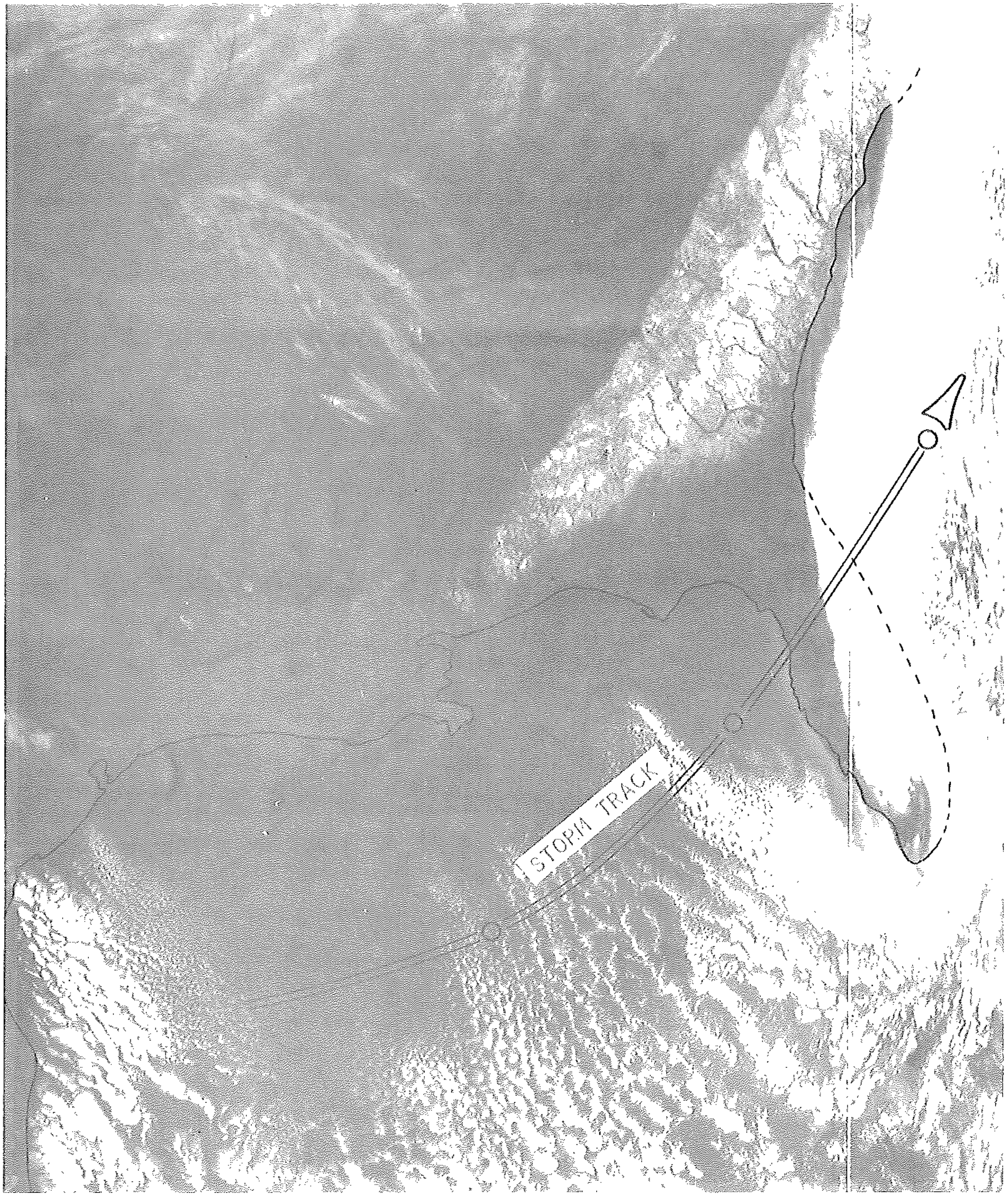


Fig. 4. NOAA-2 VHRR 1606GMT, February 11, 1973. Note location of heavy snow band over Central Georgia and the Carolinas.

Amounts of less than 4 inches (for which Traveler's Advisories may be issued by the National Weather Service)may occur for most any location in the state during February and mostly in the north and central portions from December through March including a rare occurrence in April, November, or late October. For example, Bainbridge, in extreme southwestern Georgia, has received an inch of snow as early as November 28th (in 1912).

## COMPARISON WITH MIDWESTERN STORMS

A study of 32 midwestern snowstorms (Harmes, Reinhart W., 1970) indicates most had a heavy snow band 120-140 nautical miles north (or northwest) of the track of the surface LOW. The heavy snow band of the February 0-10 southeastern U.S. storm was about 230 nautical miles north of the surface storm track (Fig. 6).

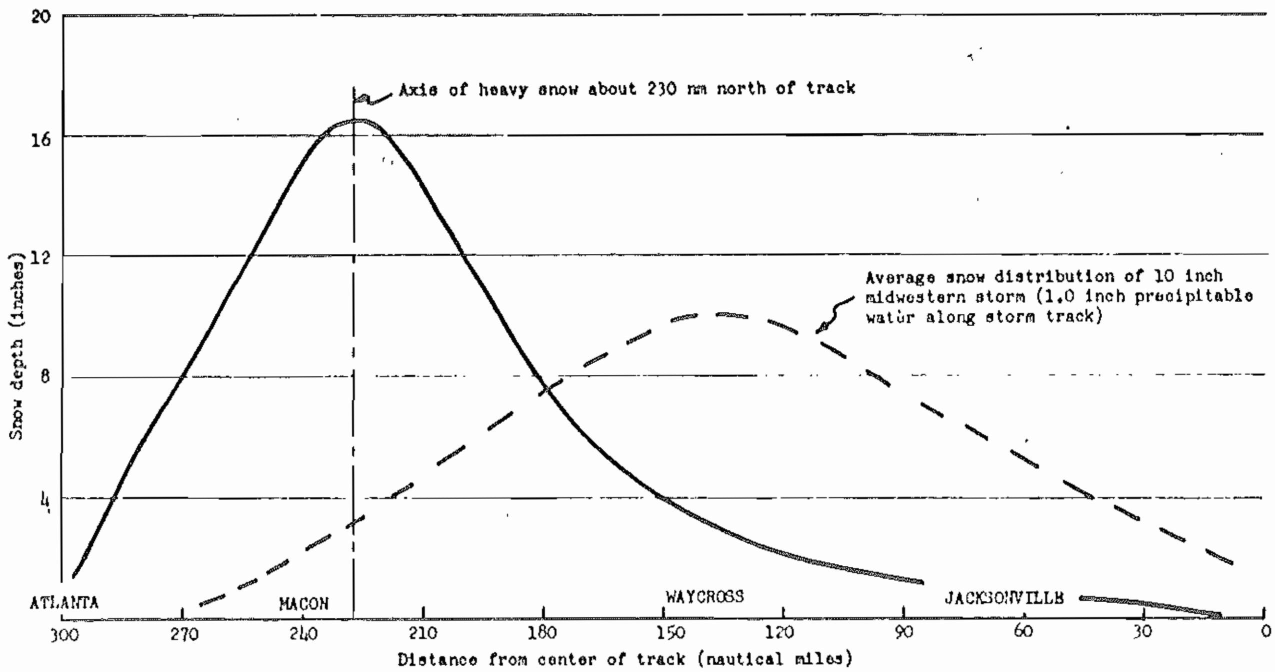


Fig. 6. Snow distribution across central Georgia, north of storm track. Precipitable water along track in eastern Gulf and north central Florida 1.56 inches. Storm of February 9-10, 1973.

Cold fronts undergo an appreciable change in slope as they reach the southern latitudes in the winter months and there appears to be a direct relationship between the slope of the cold air and the distance of the heavy snow band from the track of the surface LOW. this relationship probably applies to the width of the freezing rain band also. In the northern latitudes the freezing rain band accompanying a major snowstorm is usually on the order of 25 to 30 nautical miles in width whereas in the southern storms, the band can be 50 miles or more in width. In the record ice storm of January 7-8, 1973 across north Georgia, the freezing rain band was approximately 60 nautical miles in width, occurring just south of the 850 mb $0^{\circ}C$ isotherm which remained nearly stationary along the northern Georgia border.

The axis of a well-developed midwestern storm approaches the vertical, the 500 mb LOW usually being only 20 to 40 miles southwest of the surface LOW position. By contrast, the 500 mb LOW center of the February 9-10 storm was about 350 nautical miles west of the surface LOW at maximum development (Fig. 1), a further indication of the shallow slope of the cold air over the southeastern U.S.

There are four basic types of storms which affect the Great Lakes region and which move out of cyclogenetic areas (Petterssen, 1956) in Alberta, Canada, the lower Rockies, the Oklahoma Panhandle and the western Gulf of Mexico (Fig. 7). The average speed of movement of 17 Oklahoma Panhandle storms was 27 knots (31 mph), comparable to the February 9-10 storm which moved at about 28 knots across the Gulf of Mexico and central Florida.

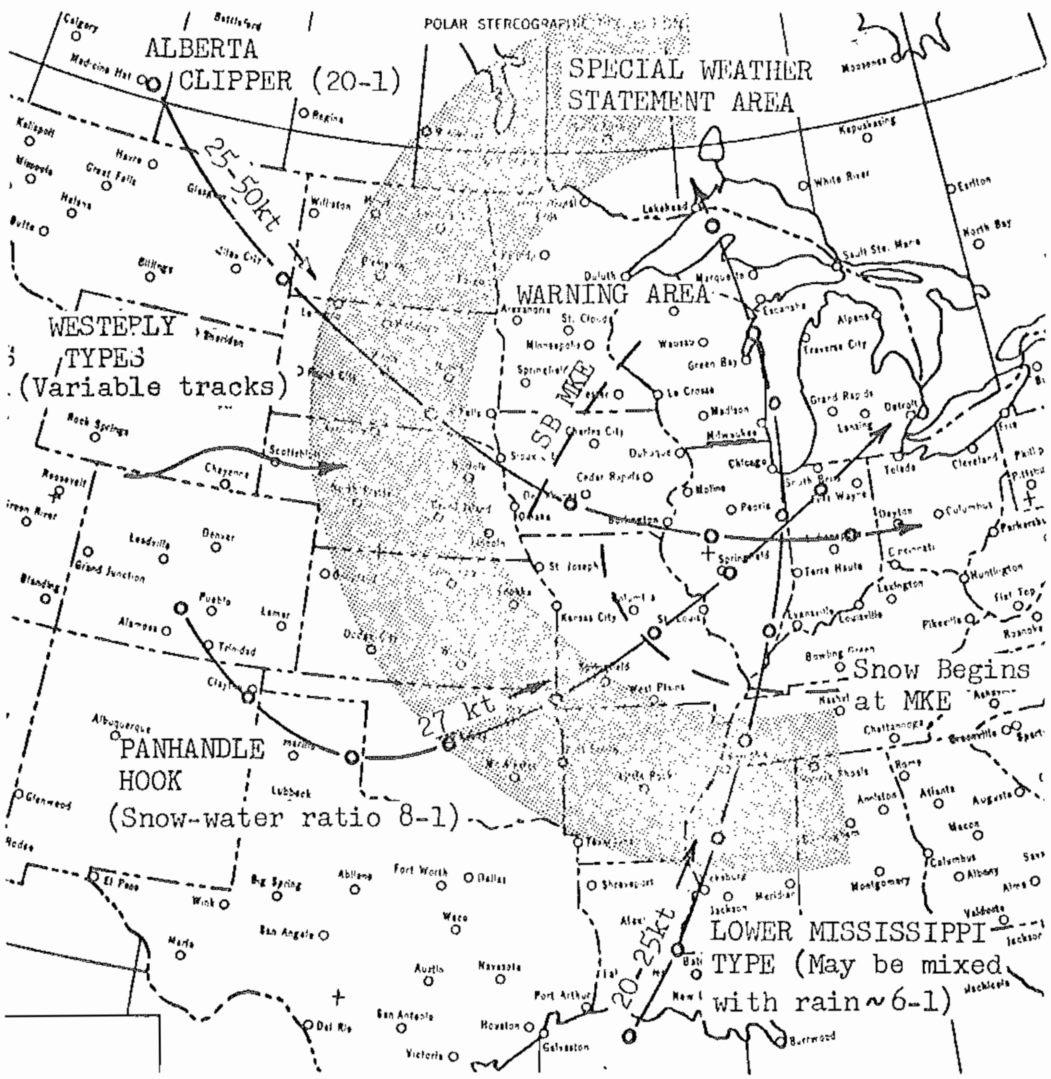


Fig. 7. Winter storm types affecting SE Wisconsin and Lower Lakes Region

In the midwestern storms it was found that a reasonably good correlation existed between the amount of snow in the heavy snow band and the precipitable water available along the surface storm track, assuming a 10 to 1 snow-water ratio. Precipitable water along the storm track of the February 9-10 storm was 1.56 inches in the eastern Gulf of Mexico which correlates very well (at the 10 to 1 ratio) with the 16 plus inches of snow in the heavy snow band extending from Columbus to Macon to Augusta, and northeastward into the Carolinas.

Objective estimates of precipitable water can be obtained based on detailed guidance from the National Meteorological Center primitive equation model or subjective estimates can be made for the vicinity of the storm track using extrapolation techniques.

PROPOSED FORECAST PROCEDURES

Although a study of many snowstorms would be desirable in developing a model for the southeastern U.S., experience gained from studies of Midwestern snowstorms and a detailed study of one of the all-time record snows in central and southeast Georgia indicates comparisons which could be of use in quantitative snow forecasting from precipitable water available along the surface storm track. The curves shown on Fig. 6 could be applied to estimate snow distribution, pending study of additional storms.

A review of the relationship between a number of past storm tracks and limited snowfall data gives indication that the 230 nautical mile distance of the heavy snow band from the surface storm track appears reasonable in major southeastern U.S. storms. For example, Atlanta's record snowfall of 8.3 inches (10.3 inches at the downtown city office) which occurred on January 23,1940 had a surface storm track across northern Florida. The all-time record snow for Chattanooga was 12.0 inches on December 4, 1886 which suggests a storm track over land across southern Georgia. It is conceivable that the excessive precipitation which occurred across central Georgia (16 plus inches) was due in great part to the full maritime trajectory of the storm across the Gulf of Mexico with near maximum winter season precipitable water available (1.56 inches).

In addition to the usual examination of guidance material, the following procedure is recommended for forecasting snow in Georgia:

1. Examine synoptic charts, satellite maps, and occurrence of snow along Texas Gulf coast to determine existence of deepening storm center in or near the cyclogenic area of the western Gulf. (Strong SE 850 mb wind at Boothevilie may be a clue.)

2. Plot several past positions of 850 mb $0^{o}C$ isotherm approaching Georgia.

3. Extrapolate the isotherm into Georgia giving consideration to 500 mb flow, blocking effect of the Bermuda HIGH and forecast position of 540-meter (1000-500 mb) thickness line which often coincides with the isotherm. Keep in mind the tendency of cold air wedges to flatten as they move southward. In general, snow will occur north of the 850 mb 0°C isotherm, and freezing rain and sleet in a 30 to 60 mile band to the south. Heaviest snow is likely in the area between the 0°C isotherm and the -5°C dewpoint line (George, Joseph J., 1960).

4. Track 3-hourly positions of the surface LOW, extrapolate in the general direction of the 500 mb wind-flow. 22 to 28 knots appears to be a reasonable speed of movement. Snow will generally begin in western Georgia by the time the LOW is south of Mobile if the track appears oriented toward central or northern Florida.

5. Forecast the precipitable water (surface to 500 mb) available along the forecasted surface storm track in the eastern Gulf of Mexico, east of 85° W Longitude.

6. Multiply the forecast precipitable water by 10 to approximate the greatest depth of snowfall (in inches) along the axis of heaviest snow. From the diagrams (Figs. 6 and 8), estimate the general snow distribution pattern.

7. Bracket the objective snow accumulation estimate with forecast amounts which appear most reasonable for the storm situation. Suggested forecast values (in inches) are as follows:

| | |
|---|---|
| 1 or 2 | 4 or more |
| 1 to 3 | 6 or more |
| 2 to 4 | 8 or more |
| 3 to 6 | |

8. Issue appropriate Watch or Warning.

Fig. 8 shows location of common Gulf storm tracks (A,B and C) which affect Georgia. The corresponding heavy snow axes for the tracks (A', B' and C') are also shown. Track A is based upon the February 9-10 storm and also shows position of LOW center when snow began at Columbus and Augusta. The dashed lines indicate progressive movement of the 850 mb 0°C isotherm across the state during the storm. Snow began at Jacksonville at 1358Z with the arrival of the isotherm.

Studies have been made which relate heavy snow areas to position of the 850 mb LOW (Hanks, Howard H., Jr., Dean R. DeHarpporte, and Eugene C. Grueber, 1967). A disadvantage of this method is the fact that 850 mb charts are received only twice daily and changes can be considerable in a 12 hour period. The procedure proposed here makes use of 3-hourly surface charts (and an occasional hourly sectional chart or other information)to continuously monitor progress of the storm and predict

EARLY WARNING SIGNS FOR
PREPARATION OF WINTER STORM WATCH

1. Satellite picture shows heavy cloud cover or vortex in western Gulf with snow occurring along Texas Gulf coast.
2. Boothville RAOB indicates SE or SSE wind of 30 knots or more at 850 mbs.
3. Brownsville RAOB indicates NW wind of 30 or 40 knots.
4. 850 mb $0^{\circ}C$. isotherm shows past 24 hour movement which indicates extrapolation well into Georgia likely
5. 500 mb temperatures over SE Texas $-19^{\circ}C$. or colder with cold air advection expected.
6. Strong PVA indicated over Alabama and Georgia.
7. Pressure falls at surface over Alabama and Georgia
8. Jet stream over Georgia in strong SW flow indicates location of heavy snow band (note 500 mb winds also)
9. Precipitable water along track of surface storm gives indication of snow amounts likely along heavy snow band (10 to 1 ratio) about 230 NM north of track.

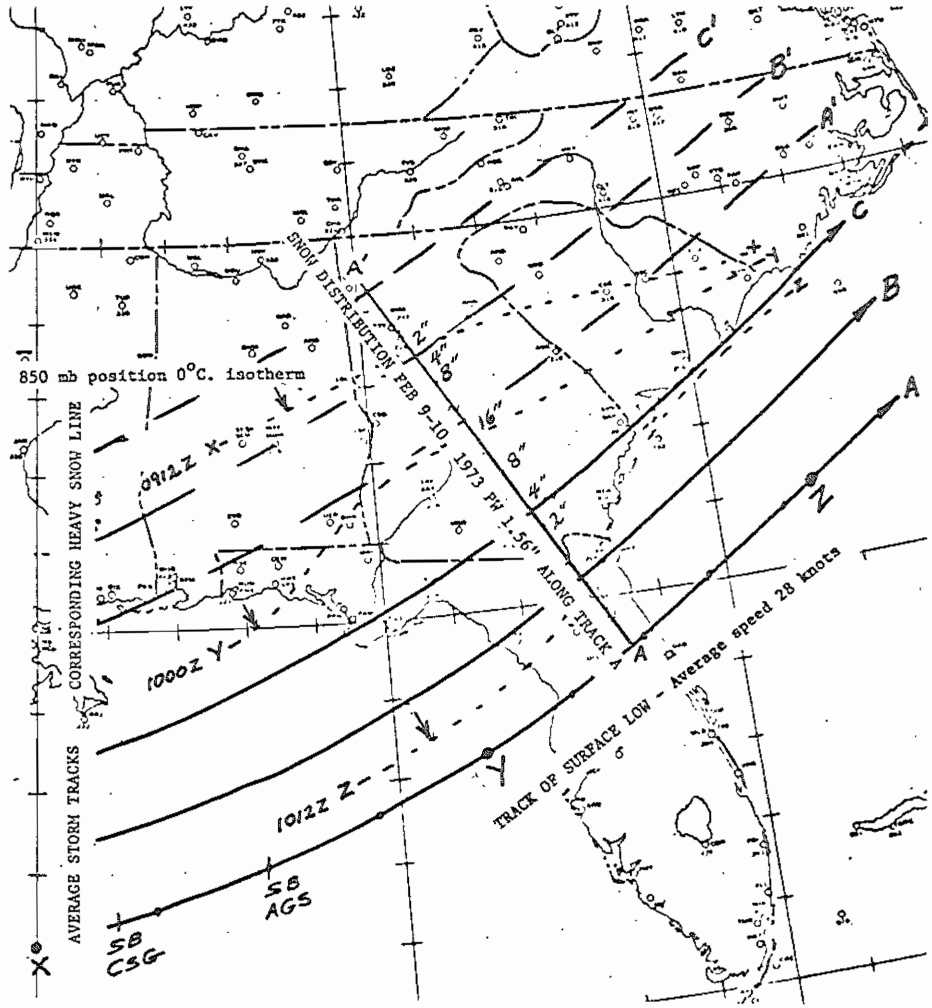


Fig. 8 Location of common Gulf storm tracks (A,B, and C) which affect Georgia.

its future path. This is extremely important since an error of 30 or 40 miles in location of the storm track can mean an error of 4 inches or more in the predicted snowfall.

A major problem in the Gulf of Mexico has been lack of data, which has precluded a reliable analysis. The data buoy program and more adequate satellite coverage give promise of improved storm tracking capability.

## SUMMARY

It was determined from this study that the flattening of a cold airmass reaching Georgia and the southeastern U.S. in the winter months has a pronounced effect on the snow distribution patterns of Gulf storms as compared to the typical midwestern U.S. storm. Heavy snow bands average 120-140 nautical miles in the Gulf storm of February 9-10, 1973. The jet stream location or axis of strongest winds at 500 mb over Georgia can also be helpful in anticipating the future location of the heavy snow band.

Relationships using precipitable water values ahead of the approaching storm along surface storm track can provide good estimates of the snow to be expected along the axis of heavy snow (at the 10-1 snow-water ratio) in the midwestern storm. This procedure appears to be fairly reliable in the southeastern storm, although a considerable number of storms should be studied to determine more exact relationships.

Climatological considerations should be used as additional guidelines. For example, examination of 74 seasons of records suggests that heavy snows of 4 inches or more are unlikely south of the Albany-Alma-Savannah line. Smaller amounts, however, justifying the issuance of Traveler's Advisories, could occur anywhere in the state during February.

The suggested forecasting technique should be tested with future storms to determine areas where improvement is needed and to refine the procedure.

## ACKNOWLEDGMENTS

The author is appreciative of the ideas and suggestions contributed by the staff at WSFO, Atlanta.

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December 18, 1973

ERRATA SHEET

NOAA Technical Memorandum NWS SR-74

"Midwestern Snowstorm Models and the February 1973 Storm Over Georgia"
by Reinhart Harms

Correction: DELETE Line 5 and remainder of paragraph 4 on page 12.

INSERT instead:

120-140 nautical miles north of the midwestern storm tracks compared to about 230 nautical miles in the Gulf storm of February 9-10, 1973. The jet stream location or axis of strongest winds at 500 mb over Georgia can also be helpful in anticipating the future location of the heavy snow band.